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Waste Minimization Assessment for Manufacturer of Gravure-Coated Metalized Paper and Metalized Film

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Abstract

The U.S. Environmental Protection Agency (EPA) has funded a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the expertise to do so. In an effort to assist these manufacturers Waste Minimization Assessment Centers (WMACs) were established at selected universities, and procedures were adapted from the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). That document has been superseded by the *Facility Pollution Prevention Guide* (EPA/600/R-92/088, May 1992). The WMAC team at the University of Tennessee performed an assessment at a plant that manufactures gravure-coated metalized paper and film. White coated paper purchased as a raw material is coated with a water-based or solvent-based mixture, and a thin layer of aluminum is deposited on the coating. Another coating is applied on top of the metalized surface. Rolls of film bought by the plant also receive a thin layer of aluminum. The team's report, detailing findings and recommendations, indicated that a large quantity of solvent evaporates from the plant's processes and that a large quantity of unused coating mixture is wasted. The greatest cost savings can be achieved by the plant through the installation of an automated system for mixing and diluting coating mixtures.

This Research Brief was developed by the principal investigators and EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center.

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Introduction

The amount of waste generated by industrial plants has become an increasingly costly problem for manufacturers and an additional stress on the environment. One solution to the problem of waste generation is to reduce or eliminate the waste at its source.

University City Science Center (Philadelphia, PA) has begun a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the in-house expertise to do so. Under agreement with EPA's Risk Reduction Engineering Laboratory, the Science Center has established three WMACs. This assessment was done by engineering faculty and students at the University of Tennessee's WMAC. The assessment teams have considerable direct experience with process operations in manufacturing plants and also have the knowledge and skills needed to minimize waste generation.

The waste minimization assessments are done for small and medium-size manufacturers at no out-of-pocket cost to the client. To qualify for the assessment, each client must fall within Standard Industrial Classification Code 20-39, have gross annual sales not exceeding $75 million, employ no more than 500 persons, and lack in-house expertise in waste minimization.

The potential benefits of the pilot project include minimization of the amount of waste generated by manufacturers and reduction of waste treatment and disposal costs for participating plants. In addition, the project provides valuable experience for graduate and undergraduate students who participate in the program and a cleaner environment without more regulations and higher costs for manufacturers.

Methodology of Assessments

The waste minimization assessments require several site visits to each client served. In general, the WMACs follow the procedures outlined in the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). The WMAC staff locate the sources of waste in the plant and identify the current disposal or treatment methods and their associated costs. They then identify and analyze a variety of ways to reduce or eliminate the waste. Specific measures to achieve that goal are recommended and the essential supporting technological and economic information is developed. Finally, a confidential report that details the WMAC's findings and recommendations (including cost savings, implementation costs, and payback times) is prepared for each client.

Plant Background

The plant produces gravure-coated metalized paper and metalized polypropylene and polyester film for use in labeling and wrapping food products. It operates 8,760 hr/yr to produce > 14 x 10^6 lb/yr of product.

Manufacturing Process

The plant's products are manufactured from raw paper and film received in bulk rolls. Other raw materials include water-based and solvent-based coating mixtures, aluminum wire (for vapor deposition coating), liquid nitrogen, and diluting solvents.

Diluting solvents (three different organic-solvent-based coating mixtures and a water-based coating mixture) are received in bulk quantities and stored. The organic-solvent-based coating mixtures are diluted with methyl ethyl ketone (MEK) as required and transported to the pre-coater. Water-based coating mixture is diluted with isopropanol and transported to either the pre-coater or top-coater.

Raw white coated paper is processed in the pre-coater where a coating is applied to enhance the gloss of the paper and provide a good surface for aluminum adhesion during later vacuum metalization. Two coatings are applied to the paper, and in some cases, both sides of the paper are coated. One of the three organic-solvent-based coatings or the water-based coating is used for each coating application; the first and second coating applications may or may not use the same coating mixture. Following coating, the paper is dried in the pre-coater oven.

Each coated paper roll from the pre-coater is transported to one of two vacuum metalizers. Rolls of polypropylene and polyester film are processed in a specialized vacuum metalizer. A thin layer of aluminum is deposited on the paper and film through vapor-deposition. About half of the metalized film is cut to specification in the metalizer and sent directly to shipping. The rest of the film is sent to the finishing, rewind, and slitting area of the plant prior to shipping.

The metalized paper is transported to the top-coater where a coating is applied to the metalized surface in the same manner that the initial coating was applied in the pre-coater. The top coat (supplied by the water-based coating) acts as a printing primer and provides a clear protective layer. The coated paper is dried in the top-coater oven and sent to the finishing, rewind, and slitting area prior to shipping.

An abbreviated process flow diagram is shown in Figure 1.

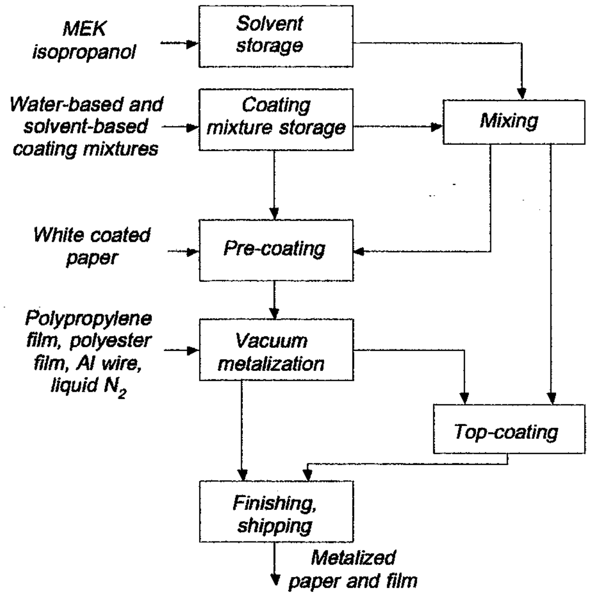

Figure 1. *Abbreviated process flow diagram.*

Existing Waste Management Practices

This plant operates an onsite solvent recovery still to recover MEK from solvent wastes. Recovered solvent is used for diluting coating mixtures and cleanup.

Waste Minimization Opportunities

The type of waste currently generated by the plant, the source of the waste, the quantity of the waste, the waste management method, and the annual waste management cost for each waste stream identified are given in Table 1.

Table 2 shows the opportunities for waste minimization that the WMAC team recommended for the plant. The minimization opportunity, type of waste, the possible waste reduction and associated savings, and the implementation cost along with the simple payback time are given in the table. The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. All values should be considered in that context.

It should be noted that the financial savings of the minimization opportunities result from the need for less raw material and from reduced present and future costs associated with waste management. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that would result when the opportunities are implemented in a package.

This research brief summarizes part of the work done under Cooperative Agreement No. CR-814903 by the University City Science Center under the sponsorship of the U.S. Environmental Protection Agency. The EPA Project Officer was **Emma Lou George**.

Table 1. *Summary of Current Waste Generation*

Waste Generated	Source of Waste	Annual Quantity Generated (lb)	Waste Management Method	Annual Waste Management Cost*
Isopropanol spills and leaks	Solvent storage	440	Shipped offsite	$420
Organic solvent evaporation	Mixing and supply drums in pre-coating	24,750	Evaporates to plant air	9,650
Water-based coating mixture spills and leaks	Coating-mixture storage	680	Shipped offsite	720
Off-specification water-based coating mixture	Mixing of coating mixture	6,250	Shipped offsite	6,760
Waste paper	Pre-coating	960,000	Baled; sold to recycler	621,180[1]
Organic solvent evaporation	Drying during pre-coating	1,740,000	Ducted to onsite incinerator; vented	940
Isopropanol evaporation	Drying during pre-coating	489,000	Ducted to onsite incinerator; vented	260
Isopropanol evaporation	Drying during top-coating	489,000	Evaporates to plant air	0
Isopropanol evaporation	Supply drums in pre-coating and top-coating	3,560	Evaporates to plant air	1,070
Unused water-based coating mixture	Cleaning of pre-coater and top-coater	5,360	Shipped offsite	5,790
Solvent-soaked cleaning rags	Cleaning of pre-coater and top-coater	11,680	Shipped offsite; incinerated	26,640
Spent isopropanol cleaning solvent	Cleaning of pre-coater and top-coater	17,460	Shipped offsite	18,440
Scrap aluminum	Vacuum metalizer	45,000	Sold to recycler	64,030
Nitrogen gas	Vacuum metalizer	9,631,320	Vented from plant	402,240
Polypropylene and polyester film scrap	Vacuum metalizer	150,000	Shipped to landfill	289,210
Cardboard cores	Vacuum metalizer	98,280	Shipped to landfill	840
Organic solvent evaporation	Cleaning of pre-coater and top-coater	15,180	Evaporates to plant air	6,550
Spent organic solvent	Cleaning of pre-coater and top-coater	3,560	Shipped offsite	2,570
Recoverable solvent	Spills and leaks and off-specification and unused coating mixture	12,900	Reused onsite	1,500
Still bottoms	Onsite distillation unit	30,110	Shipped offsite	35,790
Dry coating residue	Onsite distillation unit	1,760	Shipped offsite	4,420

* Includes waste treatment, disposal, and handling costs and applicable raw material costs.
[1] Net cost of waste stream. (Includes cost of handling waste plus raw material cost less revenue received.)

Table 2. *Summary of Recommended Waste Minimization Opportunities*

Minimization Opportunity	Waste Stream Reduced	Annual Waste Reduction: Quantity (lb)	Annual Waste Reduction: Percent	Net Annual Savings	Implementation Cost	Simple Payback (yr)
Install a system to automate the mixing and diluting of coating mixtures to reduce unnecessary waste and solvent evaporation.	Off-specification water-based coating mixture	6,250	100	$35,200	$45,000	1.3
	Unused water-based coating mixture	5,360	100			
	Still bottoms	8,140	27			
	Dry coating residue	480	27			
	Organic solvent evaporation	24,750	100			
	Isopropanol evaporation	3,560	100			
Contract with an outside firm to clean rags and return them to the plant for reuse.	Solvent-soaked cleaning rags	—[1]	—	19,500	0	Immediate
Cover drums containing coating mixture during pre-coat and top-coat operations to reduce evaporative losses.	Organic solvent evaporation	12,380	50	5,360	250	0.1
	Isopropanol evaporation	1,780	50			
Extend distillation run time to maximize solvent recovery onsite.	Still bottoms	27,100	90	12,600	0	Immediate

[1] No waste reduction will result from implementation of this opportunity.